International Journal of Engineering Inventions
e-ISSN: 2278-7461, p-ISSN: 2319-6491
Volume 12, Issue 7 [July. 2023] PP: 152-157

The Dynamics Modeling between Torque and Rotational Angles & Time Parameters in the Curve of Heavy Vehicle

Run Xu[12], Sangshik Kim[1], JaeBok Seol[1], Jaekyung Sung[1], Taehyeon Nam[1], HyoJun Ahn[1], Jiaguang Liu [2], Jing Yu [2], Yonggen Wu[3], Dayong Li[3],' Zhao Zhang[3], Tao Yu[3], Junfeng Wen[3]

[1] Gyeongsang National University, Materials Engineering Division, Gyeongsangnam-Do,Chinju 52828, Korea
[2] Yantai Institute of Technology, Electromechanical Department, Yantai 264005, China
[3]Yantai University, School of Electromechanical & Automotive Engineering, Yantai 264005, China

Abstract: *As the rotational angle may enhance the torque will have stability scope in curve of vehicle while as time may enhance it will decrease to stability gradually at the same curve. As the power enhances it may enhance correspondingly meanwhile as the rotational speed decreases it may enhance as well. The maximum torque has attained 130kNm in the curve of 150r/m and 523kW meanwhile the second maximum one has attained 70kNm in the same to 100r/m and 208kW. At last the maximum one will reach in 3.2kNm with the 250r/m and 208kW in curve of vehicle dynamics.*

Keywords: *modeling; torque; rotational angles;one circles; curve; heavy vehicle; dynamics; parameters*

Date of Submission: 10-07-2023 Date of acceptance: 22-07-2023

I. Introduction

The power transmission of an heavy vehicle is driven by power on the curve, which is generated by the engine. Therefore, the measurement of torque is the evaluation of the heavy vehicle engine system on the curve, has an important role. This paper studies the overall performance of the heavy vehicle, including whether the curving performance of the heavy vehicle achieves the best performance, through the torque and revolution of the heavy vehicle engine. The kinematics of the heavy vehicle takes speed and torque as research parameters and torque as the main purpose of design. [1~22]Therefore, the organic combination of torque and movement is the real purpose of evaluating the heavy vehicle. Mercedes-benz's A45 AMG has a 2.0t engine of 360Hp. With the increase of horsepower, their dynamic analysis and kinematics become particularly important. Such as torque and rotational speed analysis. The torque of a truck is the most important factor. It is the main condition that designers should expect in advance that they can finish the task without failure. The heavy vehicle's power and torque etc. less trouble is the embodiment of its design level capability. The torque of the heavy vehicle is the main performance of the heavy vehicle, the torque and torque is directly reflected in its engine function. A good engine function will be achieved in a relatively short time in a curve. Therefore, this paper explores whether the data of heavy vehicle design are feasible based on the high power and torque of the heavy vehicle on here, and discusses the status of high power and high torque to meet the needs of future heavy vehicle development on a slope.

II. Calculation Results

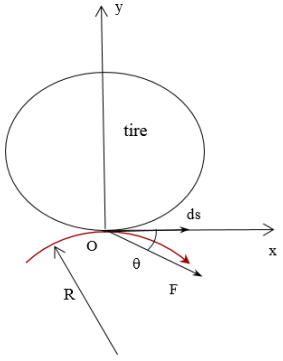

Figure 1 The graph of torque and force in curve of vehicle tire.

In Figure 1 the torque and force may be shown in curve of tire. The vehicle tire may rotate toward curve in terms of the schematic graph. Here θ is the rotational angle; F is the tire force; ds is displacement; O is original point; R is the tire radius. Their formulae will be deduced according to the graph above and they may be shown as follows.

According to energy reservation law in vehicle tire it has

$w = Fcos\frac{\theta}{2} \cdot s$ (1)

So it has

$dw = \int_{s_1}^{s_2} Fs \cdot d(cos\frac{\theta}{2})$ (2)

Here, it has $w = -\frac{F}{2}vt\int_0^{2\pi} sin\frac{\theta}{2}\, d\theta$ (3)

It has $P = -\frac{2\pi Mrn}{60R}cos\frac{\theta}{2}$ (4)

ie. $M = \frac{30PR}{\pi nrcos\frac{\theta}{2}}$ (5)

Here, M is bending moment, Nm; n is rotational speed, r/m; t is the time,s; F is the force, N; θ *is angle.*

It has $M = \frac{30PR}{\pi nrcos(\frac{\pi nt}{60})}$ (6)

It has $\theta = \frac{\pi nt}{30}$, $F = \frac{M}{R}$

III. Discussions

According to the above formulae the torque will have been solved in here whose conditions may be clarified as rotational speed from 100r/m to 250r/m and power from 85.2kW to 523kW with rotational angles from 10º to 350º. they may be discussed as below.

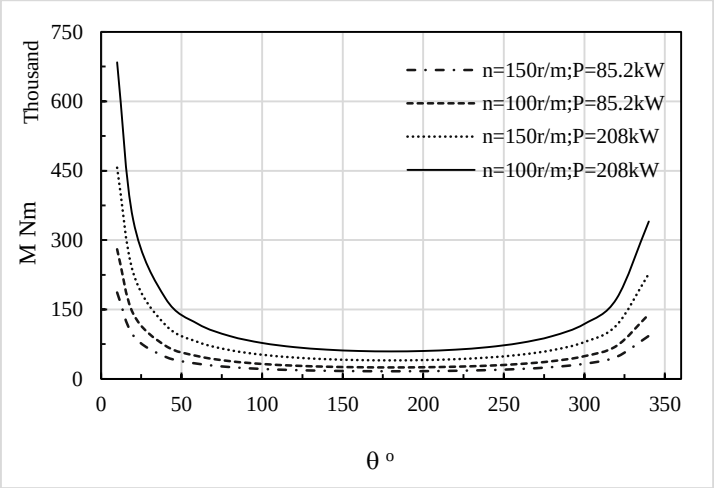

Figure 1 The graph of torque and rotational angle with various rotational speed and power.

From Figure 1 it may be seen that the torque will decrease firstly and then maintain a constant enhance finally with enhancing the rotational angle from 10º to 350º. The torque may decrease from 700kNm to 80kNm firstly at the rotational speed to be 100r/m and power to be 208kW. As the rotational speed enhances to 150r/m it may decrease to 30kNm while the power reduces to 85.2kW it may decrease to 20kNm at the stable periodicity within rotational angle to be 75º~250º. That means that enhancing the rotational speed and reducing power may have reduced the torque. Eventually it will enhance again when the angle becomes from 250º to 350º.

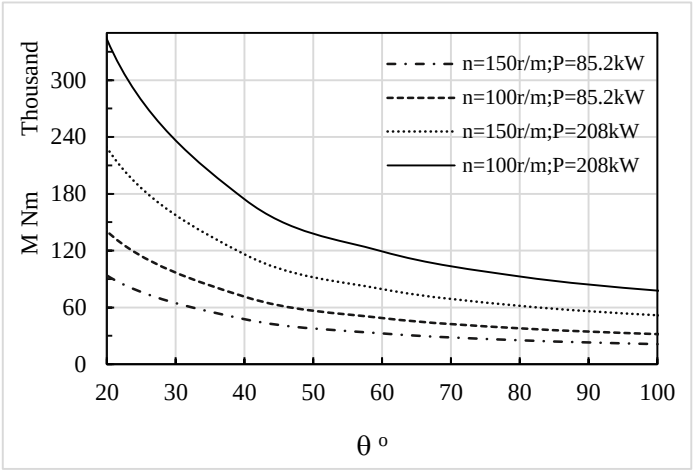

Figure 2 The graph of torque and rotational angle amplified from Figure 1 with various rotational speed and power in curve.

From Figure 2 it may be seen that the torque will decrease with enhancing the rotational angle from 20º to 100º. The torque may decrease from 340kNm to 80kNm at the rotational speed to be 100r/m and power to be 208kW. As the rotational speed enhances to 150r/m it may decrease about 50kNm while the power reduces to 85.2kW it may decrease about 40kNm. That means that enhancing the rotational speed and reducing power may have reduced the torque.

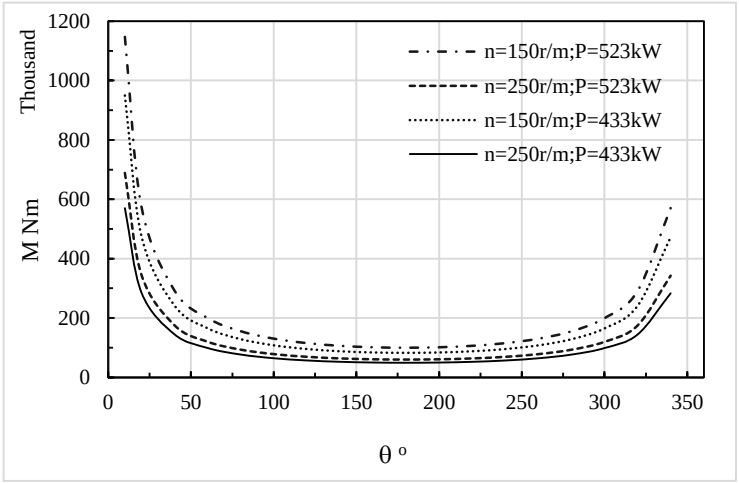

Figure 3 The graph of torque and rotational angles with various rotational speed and power.

From Figure 3 it may be seen that the torque will decrease firstly and then maintain a constant enhance finally with enhancing the rotational angle from 10º to 350º. The torque may decrease from 1180kNm to 170kNm firstly at the rotational speed to be 150r/m and power to be 523kW. As the rotational speed enhances to 250r/m it may decrease to 70kNm while the power reduces to 433kW it may decrease to 100kNm at the stable periodicity within rotational angle to be 75º~250º. That means that enhancing the rotational speed and reducing power may have reduced the torque. Eventually it will enhance again when the angle becomes from 250º to 350º.

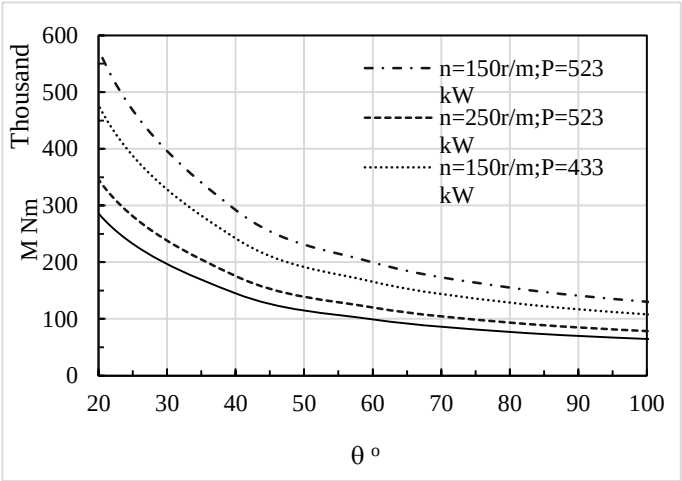

Figure 4 The graph of torque and rotational angles amplified from Figure3 with various rotational speed and power in curve of vehicle.

From Figure 4 it may be seen that the torque will decrease with enhancing the rotational angle from 20º to 100º. The torque may decrease from 570kNm to 130kNm at the rotational speed to be 150r/m and power to be 523kW. As the rotational speed enhances to 250r/m it may decrease about 150kNm while the power reduces to 433kW it may decrease about 140kNm. That means that enhancing the rotational speed and reducing power may have reduced the torque.

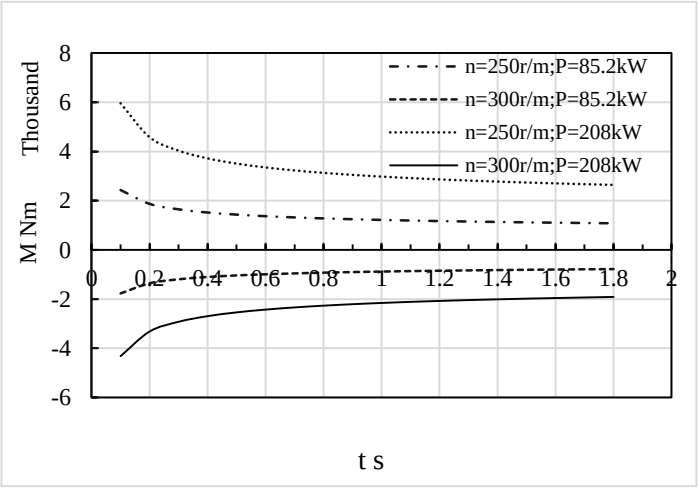

Figure 5 The graph of torque and time with various rotational speed and power in the curve.

Figure 5 shows that torque may decrease from 6kNm to 3kNm as the time enhances from 0.1s to 1.8s in the curve under the rotational speed to be 250r/m and power to be 208kW. The 3kNm may become the stability status one. When the power decreases to 85.2kW the torque will attain small one to be 1kNm.

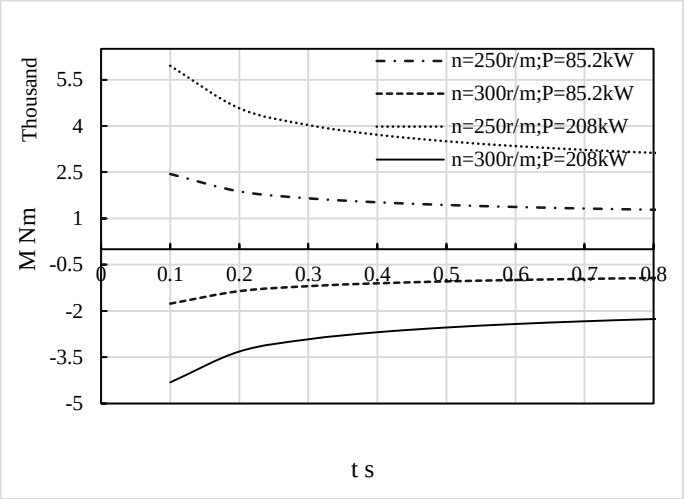

Figure 6 The graph of torque and time amplified from Figure 5 with various rotational speed and power in curve of vehicle.

Figure 6 shows the amplified part from Figure 5 which exhibits the detail status with time from 0.1s to 0.8s in the curve. The torque attains the stability one which may classify as four parts to be 3kNm、1.2kNm、-1.5kNm and -2.2kNm in stability scope in Figure 6. The torque with adjacent conditions may reach about 2kNm.

Overall, as the rotational angle may enhance the torque will have stability scope in curve of vehicle while as time may enhance it will decrease to stability gradually at the same curve. As the power enhances it may enhance correspondingly meanwhile as the rotational speed decreases it may enhance as well. The maximum torque has attained 130kNm in the curve of 150r/m and 523kW meanwhile the second maximum one has attained 70kNm in the same to 100r/m and 208kW. At last the maximum one will reach in 3.2kNm with the 250r/m and 208kW in curve of vehicle dynamics.

IV. Conclusions

As the rotational angle may enhance the torque will have stability scope in curve of vehicle while as time may enhance it will decrease to stability gradually at the same curve. As the power enhances it may enhance correspondingly meanwhile as the rotational speed decreases it may enhance as well. The maximum torque has attained 130kNm in the curve of 150r/m and 523kW meanwhile the second maximum one has attained 70kNm in the same to 100r/m and 208kW. At last the maximum one will reach in 3.2kNm with the 250r/m and 208kW in curve of vehicle dynamics.

References

[1]. Pu Lianggui, Chen Guoding, Wu Liyan. Mechanical Design [M], Advanced Education Publisher. 2015:24, 30
[2]. Fang Shijie, Qi Yaoguang. Mechanical Optimization Design [M], Machinery Industry Publisher. 2003:11
[3]. Run Xu, The Simulation of Dynamics and Consumed Fuel on Rotary Inertia Vehicles [J], International Journal of Plant Engineering and Management, 2020, June 25(2):1~12
[4]. Run Xu, The Economy Comparing With Socialism and Capitalism Country by Economics, SunText Review of Economics & Business, 2021, S1: 108, DOI: http s://doi,org/10,51737/2766- 4775,2021,S1,108
[5]. Run Xu, A New Study on China's Economic State I, Saudi Journal of Economics and Finance, 2021,5(5): 192~197, DOI: 10,36348/sjef,2021,v05i05,002
[6]. Run Xu, Younwook Kim, The Numerical Simulation of Force with Parameters of Angular Speed & Constant Angular Acceleration in Three and Five Freedoms of Robotic Arm II, Cross Current International Journal of Economics, Management and Media Studies, 2022, 4(1): 1~10
[7]. Run Xu, Younwook Kim, The Numerical Simulation of Torque with Parameters of Speed & Angular Speed and Acceleration in Five Freedoms of Robotic Arm IV, J Robotics Automation Res, 2022, 3(1): 59~63
[8]. Run Xu, The Dynamics on Hammer with Three Freedoms and Friction Vibration by Lagrange Equation in Robotic Arm, Research Square, 2020, June
[9]. Run Xu, Younwook Kim, The Numerical Simulation of Torque with Parameters of Speed & Angular Speed and High Acceleration in Five Freedoms of Robotic Arm, SunText Rev of Mat Sci, 2022, 3(1): 122
[10]. Run X, Modelling of Cost and Labor and Capital in Motor Housing Punch at Microeconomics, SunText Review of Economics & Business, 2021,S1:106
[11]. Run Xu, A Simulation between Torque and Angle with Speed on robot Mechanical Arm of Multibody system, International Journal of Research in Engineering, 2021, June 3(1), 17~19
[12]. Run Xu, Younwook Kim, The Numerical Simulation of Force with Parameters of Angular Speed & Constant Angular Acceleration in Three and Five Freedoms of Robotic Arm II, SunText Review of Material Science, 2022, 3(1): 118
[13]. Run Xu, The Numerical Simulation of Properties with High Angular Speed & Low Angular Acceleration in Three and Five Freedoms of Robotic Arm, SunText Review of Material Science, 2021, 3(1): 113

[14]. Run Xu, Boyong Hur, A Simulation between Torque and Angle with Speed on Five Freedoms of Robot Mechanical Arm in Multibody Systems, Saudi Journal of Civil Engineering, 2021, 5(5): 91~93

[15]. Run Xu, The Simulation on Dynamic of Rotary Inertia and Engine's Inflamer in Light Vehicle [J] , Journal of Mechanical Engineering Research, 2020, September 03 (02) :1~6，DOI:https://doi, org/10,30564/jme r,v3i2,1774

[16]. Run Xu , Boyong Hur, The Dynamic Simulation of Rotary Inertia on Light Vehicle -Slope I [J] , Journal of Mechanical Engineering Research, 2020, September 03 (02) :7~10,DOI:https://doi, org/10,30564/jmer,v3i2,1800

[17]. Run Xu, The Modeling of Power and Parameters on Wheel Hub for Motor in Forging Press, Scholars Journal of Engineering and Technology, 2021,9(7): 64~68

[18]. Run Xu , Screw Analysis of Head broken in Process[J] , International Journal of Plant Engineering and Management, 2019, 24 (2):126~128，DOI:10,13434/j,cnki, 1007-4546,2019,0209

[19]. Run Xu, Convergence Proving of the Theoretical & True Elongation Inequalities by Derivation and Analogy[J], Journal of Metallic Material Research, 2020,April 3(1)：15~19，DOI:https://doi,org/10,30564/jmmr,v3il,1757

[20]. Run, X, The Dynamics of Torque and Force on Hammer with Six Freedoms by Lagrange Equation in Robotic Arm，Social Science learning Education Journal，2020, 5（08）August, 300~ 309，DOI 10,15520/sslej,v5i08,2705

[21]. Run Xu, Boyong Hur, A Simulation between Torque and Angle with Speed on Five Freedoms of Robot Mechanical Arm in Multibody Systems, Saudi Journal of Civil Engineering, 2021, 5(5): 91~93

[22]. Run Xu, The Dynamic Equation on Hammer with Lagrange in Robotic Arm, Social Science learning Education Journal, 2020, August，5(8), 297-300,https://doi, org/10, 15520/sslej,v5i0 8,2703